Consensus Algorithms and Data Exchange for Trajectory Negotiation, Phase I

Completed Technology Project (2018 - 2019)

Project Introduction

Trajectory-based operations (TBO) offer a major change in air traffic management with the potential for substantial performance and safety benefits. Considering the scope of the changes, TBO concepts must pass stringent hurdles for demonstrating technical feasibility, operational benefits, and safety. A successful TBO concept should provide benefits in the near term by using existing airline and FAA systems, while offering the pathway to greatly enhanced TBO capabilities in the mid-to-far terms.

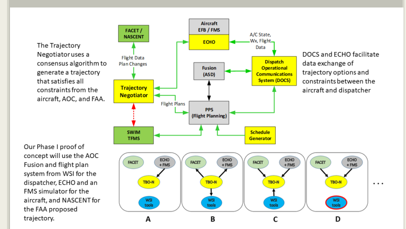
The analytical and data exchange framework proposed by Robust Analytics to develop and evaluate TBO alternatives builds from the understanding that different participants will possess superior information in selected areas. The FAA ground domain has the most complete understanding of total system traffic, weather, and constraints. Individual aircraft have superior, real-time information on flight performance capabilities, the airline operations center (AOC) acts as the information nerve center for the airline and possesses the most comprehensive understanding of the airline network and each flight's role in that network, and is responsible for achieving the airline's business objectives. One of the challenges for implementing TBO is facilitating the timely negotiations to determine trajectories that simultaneously meet airline business objectives and tight required time of arrival (RTA) for traffic management purposes. With multiple sources of uncertainty in flight operations, TBO concepts must be able to negotiate trajectory changes to satisfy multiple objectives while responding to uncertainties and constraints in the NAS.

For Phase I, Robust Analytics will describe a detailed TBO negotiation process and use case; develop an architecture for exchanging the required data among the AOC, aircraft, and traffic flow management to facilitate TBO negotiations; and conduct a proof of concept demonstration.

Anticipated Benefits

Our Negotiator prototype provides useful capabilities to include in the ATD-2 and ATD-3 demos. We propose a solution to the trajectory negotiation process common to many dynamic flight operations. The architecture provides a platform for NASA AOSP research, able to test trajectory algorithms and negotiation protocols with a AOC-aircraft communications and application testing infrastructure. Negotiator applies to new concepts such as urban air mobility that will require trajectory negotiation.

Our concept would be a mechanism for generating near term airline cost savings; over time, it supports larger benefits from enabling more comprehensive TBO capabilities into the NAS. Our architecture would support more extensive trajectory negotiation in-flight, complementing current pre-departure trajectory negotiations such as CTOP. More generally, our design supports greater sharing of airspace constraints with operators, which has



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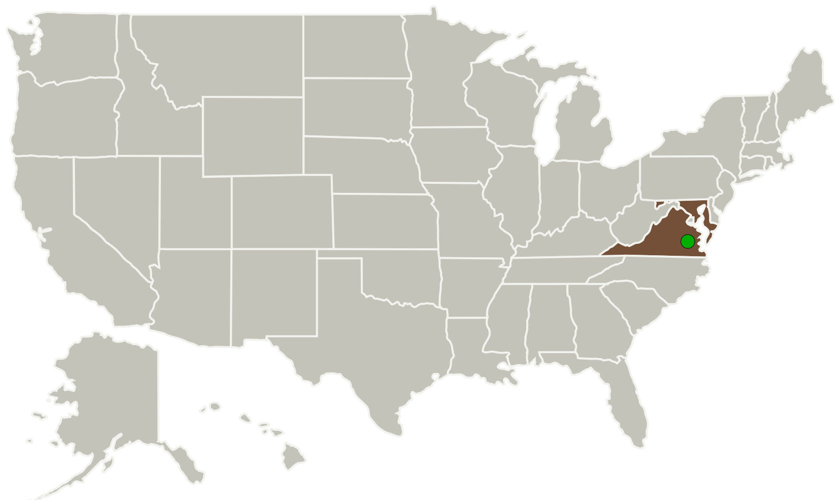
long been an objective of the airlines.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Robust Analytics	Lead Organization	Industry Women-Owned Small Business (WOSB)	Crofton, Maryland
Langley Research Center(LaRC)	Supporting Organization	NASA Center	Hampton, Virginia

Primary U.S. Work Locations	
Maryland	Virginia

Project Transitions

July 2018: Project Start

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Robust Analytics

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

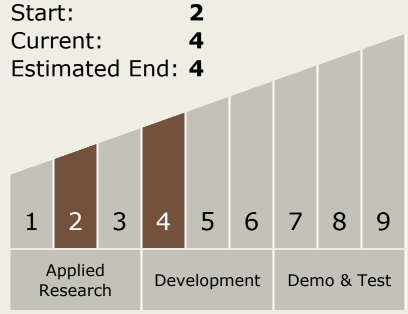
Carlos Torrez

Principal Investigator:

Shreyas Subramanian

Technology Maturity (TRL)

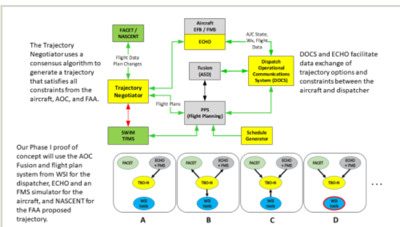
Start: **2**
Current: **4**
Estimated End: **4**



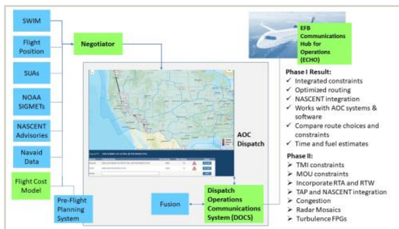
February 2019: Closed out

Closeout Documentation:
- Final Summary Chart*(https://techport.nasa.gov/file/141317)*

Images



Briefing Chart Image
Consensus Algorithms and Data Exchange for Trajectory Negotiation, Phase I *(https://techport.nasa.gov/image/132617)*



Final Summary Chart Image
Consensus Algorithms and Data Exchange for Trajectory Negotiation, Phase I *(https://techport.nasa.gov/image/131978)*

Technology Areas

Primary:

- TX16 Air Traffic Management and Range Tracking Systems
  └─ TX16.3 Traffic Management Concepts

Target Destination

Earth